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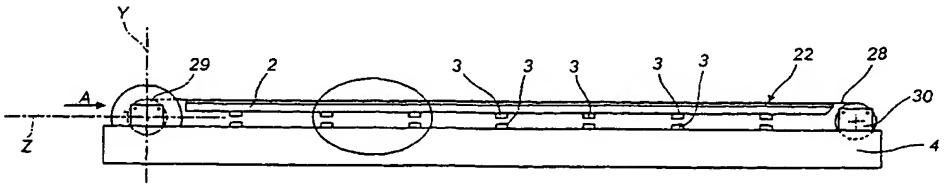
(54) Title: AN APPARATUS FOR PHYSICAL EXERCISE WITH MAGNETIC INTERACTION BETWEEN THE PARTS OF WHICH IT IS MADE



(57) Abstract: A physical exercise apparatus for recreational, rehabilitative, gymnastic or sports purposes comprises at least one mobile part (2) and at least one support part (4), interacting by means of field forces generated by magnetic fields inserted between relative parts of which the apparatus is made.

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Description

An apparatus for physical exercise with magnetic interaction between the parts of which it is made

Technical Field

The present invention relates to apparatuses for personal physical exercise, that is to say, more or less complex pieces of equipment or machines, designed for carrying out motor activity for the most widespread purposes, such as simple recreation, to achieve and maintain physical fitness and well-being, rehabilitation and gymnastics or sports training. The present invention relates in particular to an apparatus of the aforementioned type which uses stationary magnet fields which interact between the parts of which it is made.

Background Art

Amongst the exercise apparatus and machines of known construction, there are no known applications which involve the use of magnetism to maintain in dynamic equilibrium, without reciprocal contact, the parts of which the apparatus is made and which are generally susceptible of movement, whether absolute or relative, that is to say, the parts which, while maintaining the specificity typical of each piece of equipment or machine of this kind, interact by using magnetic fields to exchange relative forces and movements.

Disclosure of the Invention

The aim of the present invention is, therefore, to provide the application of magnetism to an apparatus for physical exercise, in order to obtain, selectively or in combination according to a criterion which may be defined at will: support, more or less extensive elastically yielding suspension of parts of the equipment susceptible of movement; damping of impulsive forces exchanged by the parts of the apparatus and/or the user and the

apparatus; damping of mechanical vibrations; sound and electrical insulation; accumulation and return of energy in a conservative or dissipated manner.

Accordingly, the present invention achieves the preset aims by providing a physical exercise apparatus for recreational, rehabilitative, gymnastic or sports purposes, characterised in that it comprises at least one mobile part, and at least one support part, interacting by means of forces generated by one or more stationary magnetic fields in between them.

According to the specific type of exercise apparatus the above-mentioned dynamic equilibrium may involve relative mobility of the parts in question with varying degrees, and may, for example, mean in some types of equipment only a relative stationary condition of the rigid part and the support part, with limited translation and/or rotation movements, instantaneously oscillating around a shared equilibrium position. Vice versa, in other types of apparatus said dynamic equilibrium may involve real movements of one part relative to another.

Brief Description of the Drawings

The technical features of the present invention, in accordance with the above aims, are apparent in the claims herein, and the advantages are more clearly described in the detailed description below, with reference to the accompanying drawings, which illustrate a preferred embodiment of the invention, without limiting the scope of its application, and in which:

Figure 1 is an elevation view of a first gymnastic exercise apparatus made in accordance with the present invention, in the form of a machine conventionally known as a "treadmill";

Figure 2 is an elevation view of a second gymnastic exercise apparatus made in accordance with the present invention and with a footrest for the exchange of force between the user and the apparatus;

Figure 3 is a scaled up detail of the apparatus illustrated in Figure 2;

Figure 4 is a front view of the apparatus illustrated in Figure 1, seen in direction Z as indicated by the arrow A;

Figures 5 and 6 are respectively an elevation view and a top plan view of a first embodiment of a user support part of a generic exercise apparatus;

Figure 7 is a side view of a second embodiment of the support part illustrated in Figures 5 and 6;

Figure 8 is a perspective assembly view of a third embodiment of an exercise apparatus made in accordance with the present invention;

Figures 9, 10, 11 are schematic illustrations of some parts of exercise apparatuses made in accordance with the present invention;

Figure 12 is a scaled-up view of a detail from Figure 1;

Figure 13 is a schematic diagram of the operating principle of a possible embodiment of the apparatus made in accordance with the present invention;

Figure 14 is construction detail of a part of an actual apparatus of the type illustrated in Figure 13;

Figure 15 is a partial assembly view of an exercise machine incorporating the apparatus illustrated in the previous Figures 13 and 14.

Description of a Preferred Embodiment of the Invention

With reference to Figure 1 of the accompanying drawings, the numeral 1 denotes as a whole a physical exercise apparatus for recreational, rehabilitative, gymnastic or sports purposes which is represented, by way of example and without limiting the scope of application, by a generic exercise machine known conventionally as a "treadmill".

The apparatus 1 basically comprises a user support part, in the form of a horizontal platform 22, fitted with a sliding belt 28, horizontally mobile at a suitable speed, on which the user walks or runs.

The sliding belt 28 is an endless flexible belt looped around two parallel rollers 29, 30, at least one of which is driven by a motor.

A rigid part, in particular having the shape of a flat, rectangular plate 2, is inserted, in a horizontal direction Z,

between the rollers 29 and 30, whilst, in the vertical direction Y, it is located between the sliding belt 28 and a horizontal base 4 or machine frame below.

Pairs of permanent magnets 3 are located at opposite positions on the plate 2 and the horizontal base 4.

The permanent magnets 3 are fixed and such that the opposing polarities are identical and generate a magnetic field which exerts repelling forces between the plate 2 and the base 4 (see also Figure 12). These forces push the plate upwards until it reaches a condition of equilibrium with its own weight, in the vertical direction Y, in which the plate 2 levitates above the base 4, which therefore supports it without physical contact.

Figure 4 illustrates how the pairs of permanent magnets 3 can be located between sides 31 of the platform 22 and opposite, vertical sides 32 of the base 4, to obtain a lateral confinement of the platform 22, in one or two horizontal directions X, Z, at right angles, of the space passing through the plane on which the platform 22 lies.

The magnetic support of the platform 22, in all right-angled directions of the space, therefore, makes the platform 22 float freely without any physical contact with the machine base 4.

Such a result is particularly advantageous for many aspects. Levitation and magnetic confinement allow the damping of the impact force of the user's foot against the rigid platform 22, generated by walking or running movements, which is particularly useful for reducing the risk of trauma to the bone and muscular system, or vice versa, in the case of rehabilitation this promotes a safe and more rapid recovery of movement by the person affected by an illness or accident. Levitation and magnetic confinement also allow the damping of mechanical vibrations induced on the platform 22 by the user exercising; sound and electrical insulation relative to the base 4 structure; and the return of energy in a conservative fashion by the platform 22 - base 4 system which, thanks to the magnetic field, is able to accumulate the mechanical energy received at the moment of impact, then return it at a later time.

If, as illustrated in Figure 4, further pairs of permanent

magnets 3 are added and positioned in such a way as to separate the entire structure of the apparatus 1 from the floor or the machine support surface, all of the above-mentioned advantages are supplemented by the benefit of ambient sound insulation, since architectural structures, insulated by the apparatus 1, are not reached by sound stresses or vibrations.

From the detailed description above - relative to a "treadmill" type apparatus 1 - it may immediately be deduced that the features described relative to platform 22 levitation can easily be transferred to other apparatuses, that is to say, to all equipment or machines which, for example, have a user support part, with any configuration.

Figures 5 and 6 illustrate how it is possible to make a saddle 25, for example of a "bike" - which includes in its structure a rigid part 2 with some permanent magnets 3 and is attached to a fixed support column 33, free to oscillate about a horizontal axis 34. The column 33 has a support 35 with permanent magnets 33 respectively opposite the first magnets. The magnetic field between the pairs of permanent magnets 3 may, therefore, be used to maintain the equilibrium of the saddle 25 during rotation about the axis 34.

Similar considerations may also apply to the user support parts, which are completely different, and which may be, for example, a seat 23 and/or a backrest 24 of a chair 26 of the type which are normally used on many pieces of gymnastic exercise equipment and exercise machines. The seat 23 and backrest 24, which may be made in separate parts 23a, 23b, 24a, 24b, respectively fitted with the opposite pairs of permanent magnets 3, polarised and mounted in such a way as to keep the parts 23a, 23b, 24a, 24b separate and out of contact.

Many other embodiments of the present invention are also possible. Figure 8 illustrates how the use of a magnetic field interacting between pairs of permanent magnets 3 and even combined with other damping means 36 of various types - elastic, mechanical, solid or fluid - may be used for a tilting or elastic footrest 21.

The footrest 21 can also be included in a structure 4 of a

more complex machine, for example an isotonic machine, subject to the user's muscular strength, as schematically illustrated in Figures 2 and 3, where a footrest 21 mounted in such a way that it turns about a horizontal axis 34 is held in a position of equilibrium during rotation about the axis 34 by the effect of the opposing rotational torques generated by the magnetic repulsion (or attraction - depending on the polarities selected) of pairs of permanent magnets 3, set opposite one another and symmetrically relative to the axis of rotation 34.

Other embodiments of the present invention may by obtained by inserting the means which generate the magnetic field on the actuator parts on which the user exerts a direct muscular force or even directly on the resistive means, which provide resistance to operation of the apparatus 1 by the user.

In such cases, this may be achieved for example as illustrated in Figure 9, which schematically illustrates handlebars 27, which may be gripped by the apparatus 1 user. The handlebars are fitted with the permanent magnets 3 to dampen the travel relative to a guide and support column 38. A different embodiment is illustrated in Figure 11, which shows how the permanent magnets 3 can be positioned below a set of weights 39, both to dampen the impact on the downstroke and to facilitate the initial detachment when lifting.

The magnets 3 may also be positioned at any point on the kinematic chain which links the driving force applied by the user's muscles to the resistive load applied by the apparatus 1. This can be done, for example (Figure 10) by inserting the pairs of permanent magnets 3 between two adjacent parts of the kinematic chain, connected (for example a lever, or handle, a pedal crank, or any other actuator part 40 and a part 41 integral with the resistive load) in such a way as to create, for example, a kind of elastic magnetic joint, which allows the dampened transmission of the force between the two parts 40, 41 of the chain.

In all of the examples described above, reference is made to stationary magnetic fields generated by pairs of permanent magnets 3. This must be considered only by way of example, without limiting the scope of the present invention, since it is obvious

that the magnetic interaction can be obtained between permanent magnets 3 and opposite ferromagnetic parts of the various apparatuses. As regards the magnets 3, it is also obvious that they do not necessarily have to have a permanent magnetic field, since the field can be generated using suitable electric means.

The latter statement allows an explanation of how the magnetic field can be controlled in terms of its specific characteristics, to achieve operation which is particularly effective in the management of the various types of exercise apparatuses 1, that is to say, control of the position of the mobile parts affected by the magnetic field; the position control subordinate to the force exchanged by the user and the exercise apparatus 1; the position control subordinate to the user's weight and the force exchanged by the users and the apparatus 1; or any combination of control of the above-mentioned mechanical characteristics.

A possible embodiment of the apparatus 1 designed to allow the above-mentioned operation is described with reference to Figures 13, 14 and 15.

Figure 13 illustrates an apparatus 1 of said type comprising damper means 36 which are operatively connected to each electromagnet 3 and consist of elastic elements 45 placed parallel with each electromagnet 3 so as to allow relative movements of the part 2 and the support part 4 which are elastically opposed and suitably dampened.

The elastic means can be made in many different ways, for example with mechanical spring 45 systems, or elastic supports of the type comprising rubber blocks or air cushions. The use of a system of helical springs 45 is preferable, since it allows constant rigidity, compactness and easy substitution for modifying or customising the characteristics of the apparatus 1 according to the requirements of specific categories of users.

For a particularly precise control and management of the relative movements of the mobile part 2 and the support part 4 attached to it - in all possible embodiments: footrest, platform, seat, chair, etc. - the apparatus 1 may also comprise position feedback control means 47.

For this purpose, the apparatus 1 in Figure 13 comprises a position sensor 46, preferably of the inductive type, designed to detect the extent of the relative movements of the mobile part 2 - in this case the footrest 21 of a "treadmill" - and the support part 4, and to exchange suitable signals with the position feedback control means 47 which drive each electromagnet 3 accordingly.

In this way it is possible to modify the control law of the magnetic suspension, altering the characteristics of the electromagnets 3 so as to vary the rigidity and damping.

By suitably adjusting the control algorithm which governs operation of the control means 47, it is possible to achieve a situation in which the suspension parameters depend on the frequency. The presence of position sensors 46 and the measurement of the current sent to the electromagnet coils allow the estimation and moment-by-moment modulation of the impact force, that is to say, modulation according to requirements of the intensity of the magnetic field generated by the electromagnets.

Figure 14 illustrates a real construction detail of the apparatus 1 in the basic drawing in Figure 1, in particular with stroke limiter means 48, designed to limit the extent of the relative movement of the part 2 and the support part 4.

The stroke limiter means 48 are adjustable and comprise a screw 49 with a nut and lock nut 50.

Figure 15 illustrating a partial assembly view of a prototype of a treadmill fitted with the apparatus made in accordance with the present invention, shows how the apparatus 1 not only fulfils all of the preset aims, but is also compact and relatively simple to apply to devices and machines for gymnastic exercise, of various types and sizes.

Claims

1. A physical exercise apparatus for recreational, rehabilitative, gymnastic or sports purposes, characterised in that it comprises at least one mobile part (2) and at least one support part (4), interacting with one another by means of field forces generated by a magnetic field located between them.

2. The apparatus according to claim 1, characterised in that the part (2) and the corresponding support part (4) are dynamically kept in equilibrium at least in a given direction (Y) of relative movement.

3. The apparatus according to claim 1, characterised in that the part (2) and the corresponding support part (4) are dynamically kept in equilibrium at least in a vertical direction (Y) of relative movement.

4. The apparatus according to claim 1, 2 or 3, characterised in that the part (2) is held in position relative to the support part (4) with a direct magnetic action at least in a horizontal direction of relative movement (X; Z).

5. The apparatus according to claim 1, characterised in that the support part (4) are inserted between the apparatus (1) user and the floor, the support part (4) being suspended above the floor by the magnetic field.

6. The apparatus according to claim 1, characterised in that the part (2) susceptible of movement relative to a corresponding support part (4) is attached to apparatus (1) actuator means (21, 22, 27) to which the user applies muscular force.

7. The apparatus according to claim 1 or 6, characterised in that the part (2) susceptible of movement relative to a corresponding support part (4) is attached to resistive means (39, 41) reacting to use of the apparatus (1) by the user.

8. The apparatus according to claim 1, comprising at least one kinematic chain between the actuator means (21, 22, 27), upon which the user acts, and resistive means (39, 41) reacting to the actuator means, the apparatus being characterised in that the mobile part (2) and the corresponding support part (4) are included at any position in the kinematic chain.

9. The apparatus according to claim 5, characterised in that the mobile part (2) and the corresponding support part (4) are attached to a support part (21, 22, 23, 24, 25) for the apparatus (1) user.

10. The apparatus according to claim 5 or 9, characterised in that the support part is a footrest (21).

11. The apparatus according to claim 5 or 9, characterised in that the support part is a platform (22).

12. The apparatus according to claim 9, characterised in that the support part is a seat (23) which supports the user.

13. The apparatus according to claim 9, characterised in that the support part is a backrest (24) which supports the user.

14. The apparatus according to claim 12, characterised in that the support part is a saddle (25).

15. The apparatus according to claim 12, 13 or 14, characterised in that the support part is a chair (26).

16. The apparatus according to claim 10, characterised in that the footrest (21) is connected to a structure (42) of a machine which receives the user's muscular force.

17. The apparatus according to claim 11, characterised in that the platform (22) is included in a machine with sliding belt or treadmill.

18. The apparatus according to claim 6, characterised in that the actuator means includes at least handlebars (27).

19. The apparatus according to claim 6, characterised in that the actuator means includes at least a lever (40).

20. The apparatus according to claim 6, characterised in that the actuator means include at least a footrest (21).

21. The apparatus according to claim 7, characterised in that the mobile part (2) and the support part (4) are attached to at least one weight (39), the latter being designed to oppose the user's muscular force.

22. The apparatus according to any of the foregoing claims, characterised in that the part (2) and the corresponding support part (4) exchange a magnetic action of reciprocal attraction.

23. The apparatus according to any of the foregoing claims from 1 to 21, characterised in that the part (2) and the corresponding support part (4) exchange a magnetic action of reciprocal repulsion.

24. The apparatus according to claim 22 or 23, characterised in that the part (2) and the relative support part (4) exchange a magnetic action designed to maintain their relative position about a preset point of equilibrium.

25. The apparatus according to any of the foregoing claims, characterised in that it comprises at least one permanent magnet (3) for generating the magnetic field interacting between the part (2) and the corresponding support part (4).

26. The apparatus according to any of the foregoing claims, characterised in that it comprises at least one electromagnet for generating the magnetic field interacting between the part (2) and the corresponding support part (4).

27. The apparatus according to any of the foregoing claims, characterised in that it comprises at least one electro-permanent magnet for generating the magnetic field interacting between the part (2) and the corresponding support part (4).

28. The apparatus according to claim 25 or 26, characterised in that the magnet (3) is shaped and positioned in such a way as to maintain a position of equilibrium through a force control, the force being exchanged between the part (2) and the corresponding support part (4).

29. The apparatus according to any of the claims from 25 to 27, characterised in that the magnet (3) is shaped and positioned in such a way as to maintain a position of equilibrium through a position control, the position being a preset position of the part (2) relative to the corresponding support part (4).

30. The apparatus according to any of the claims from 25 to 27, characterised in that the magnet (3) is shaped and positioned in such a way as to maintain a position of equilibrium through a preset relation between the position of the part (2) relative to the support part and a preset relation of force between the part (2) and the support part.

31. The apparatus according to any of the claims from 25 to 27, characterised in that the magnet is shaped and positioned in such a way as to maintain a position of equilibrium through a preset relation concerning the position of the part (2) relative to the support part (4), concerning a preset relation of force between the part (2) and the support part (4) and concerning the user's weight.

32. The apparatus according to any of the claims from 25 to 27, characterised in that the magnet (3) is shaped and positioned in such a way as to maintain a position of equilibrium through a preset relation of force between the part (2) and the support part (4).

33. The apparatus according to any of the foregoing claims, characterised in that at least the rigid part (2) or the support part (4) is made of a ferromagnetic material.

34. The apparatus according to any of the claims from 1 to 33, characterised in that at least the rigid part (2) or the support part (4) is made of a diamagnetic material and is fitted with at least one magnet (3).

35. The apparatus according to claim 26, characterised in that it comprises damper means (36) connected to the electromagnet (3).

36. The apparatus according to claim 35, characterised in that the damper means (36) include elastic elements (45) connected in parallel to the electromagnet (3).

37. The apparatus according to claim 35 or 36, characterised in that the elastic elements (45) include a system of helical springs.

38. The apparatus according to any of the claims from 35 to 37, characterised in that it comprises feedback control means that drive the electromagnet (3).

39. The apparatus according to claim 38, characterised in that it comprises a sensor designed to detect the extent of a suitable variable physical quantity, the feedback control means driving the electromagnet (3) according to the readings of the sensor.

40. The apparatus according to claim 39, characterised in that the sensor is a position sensor (46), designed to detect the extent of

the relative movements of the mobile part (2) and the support part (4), the feedback control means operating with the position control (47) and driving the electromagnet (3) according to the movements detected by the position sensor (46).

41. The apparatus according to claim 40, characterised in that the position sensor (46) is of the inductive type.

42. The apparatus according to any of the claims from 35 to 41, characterised in that it comprises stroke limiter means (48) designed to limit the extent of the movement of the mobile part (2) relative to the support part (4).

43. The apparatus according to claim 42, characterised in that the travel limiter means (48) are adjustable.

44. The apparatus according to any of the foregoing claims, characterised in that the magnetic field is stationary.

45. The apparatus according to any of the claims from 1 to 43, characterised in that the magnetic field is variable.

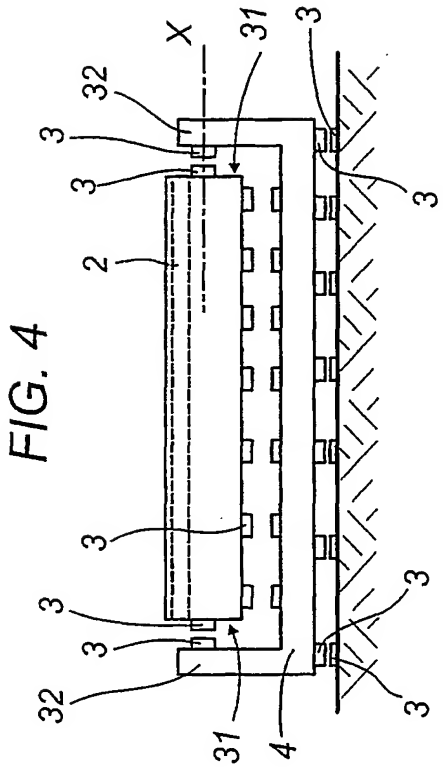


FIG. 4

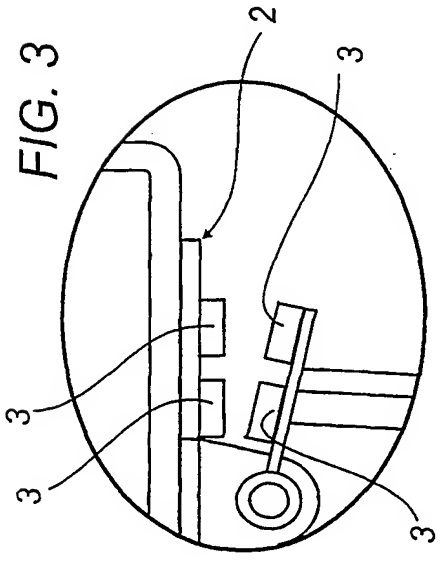


FIG. 3

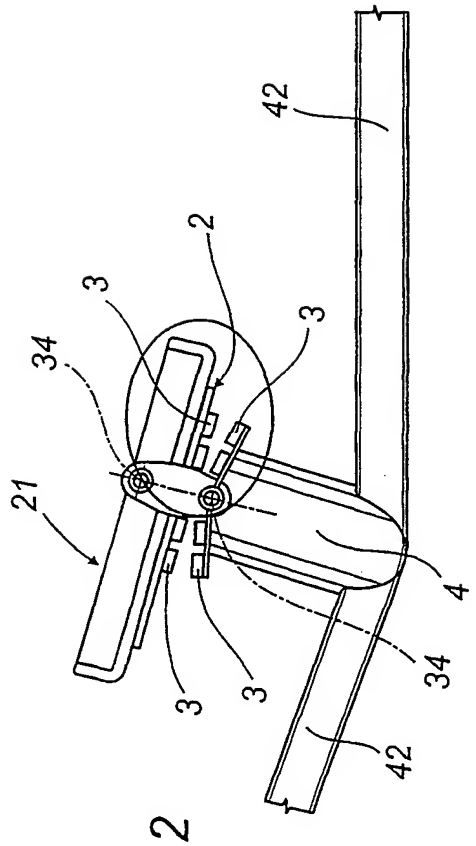


FIG. 2

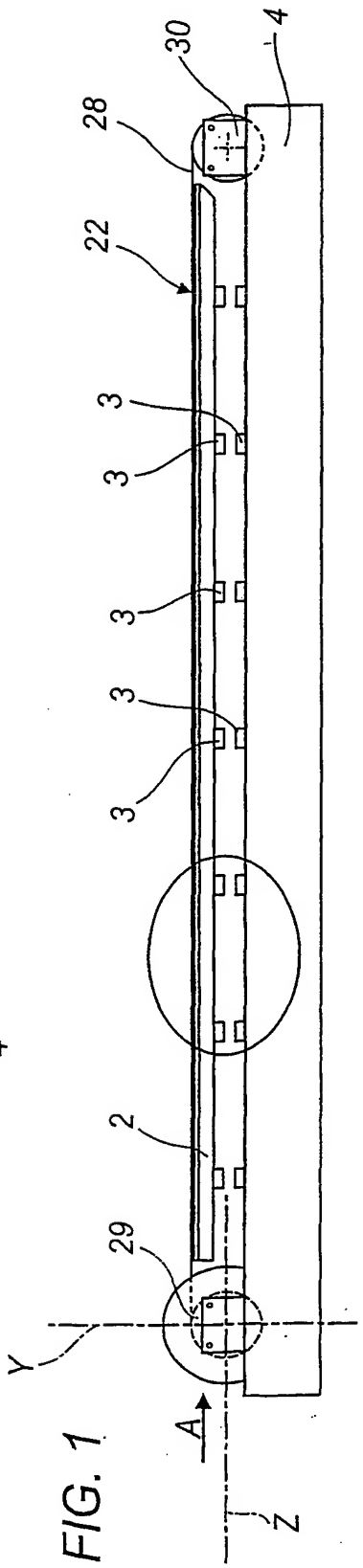


FIG. 1

FIG. 8

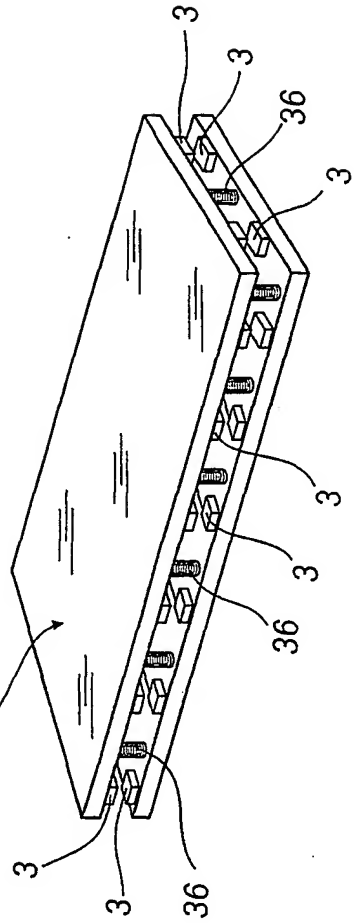


FIG. 6

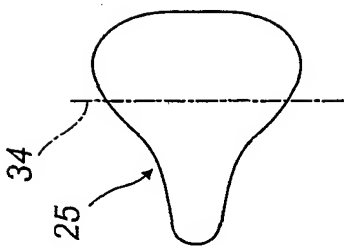


FIG. 5

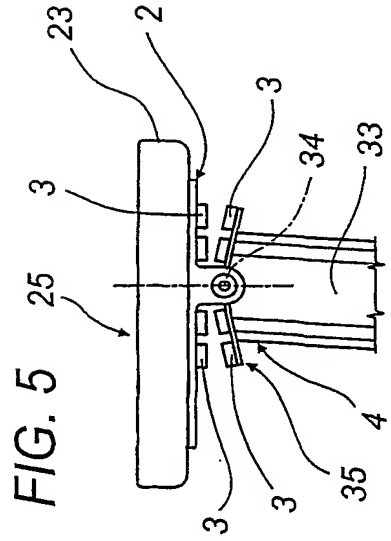


FIG. 7

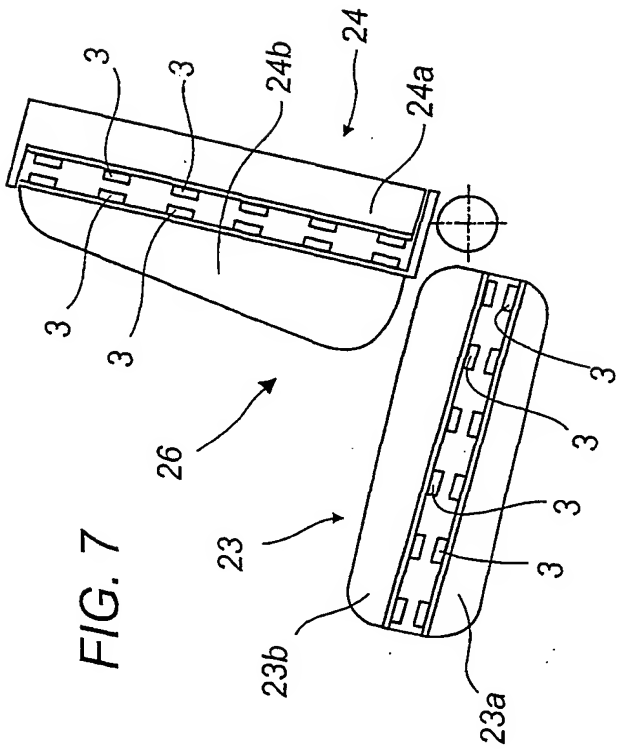


FIG. 9

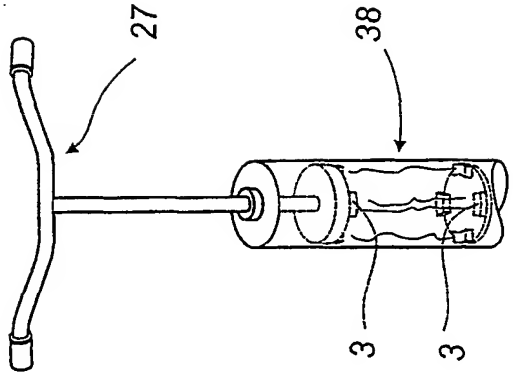


FIG. 10

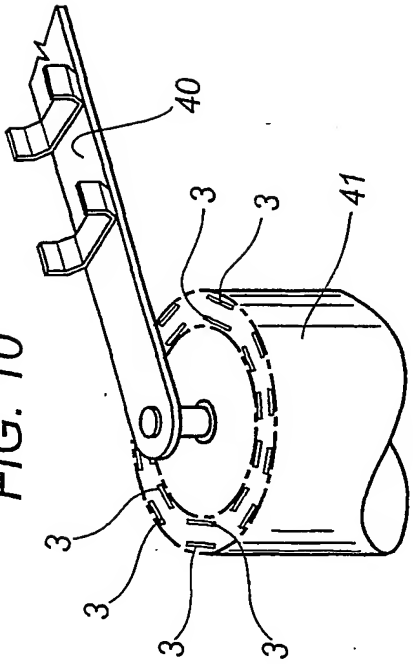


FIG. 12

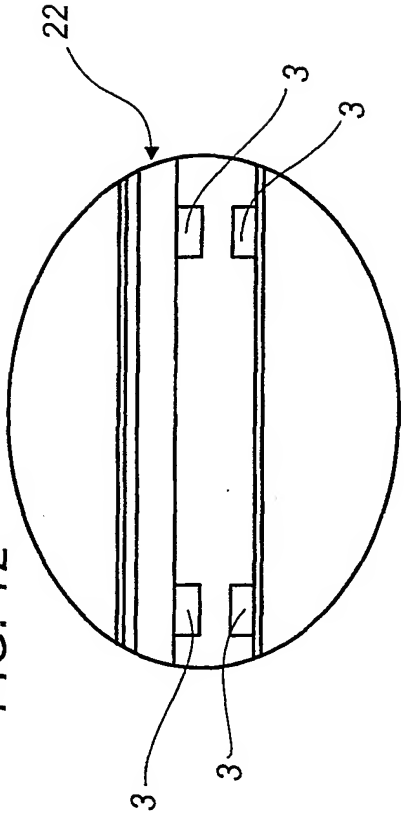


FIG. 11

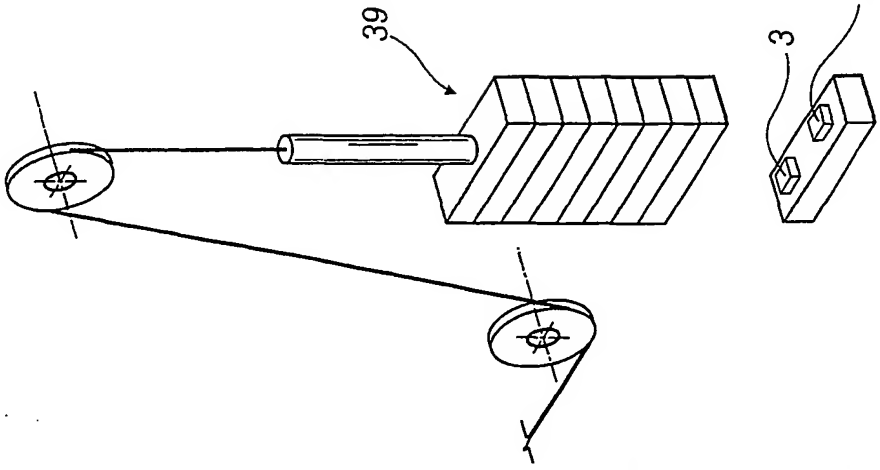


FIG. 14

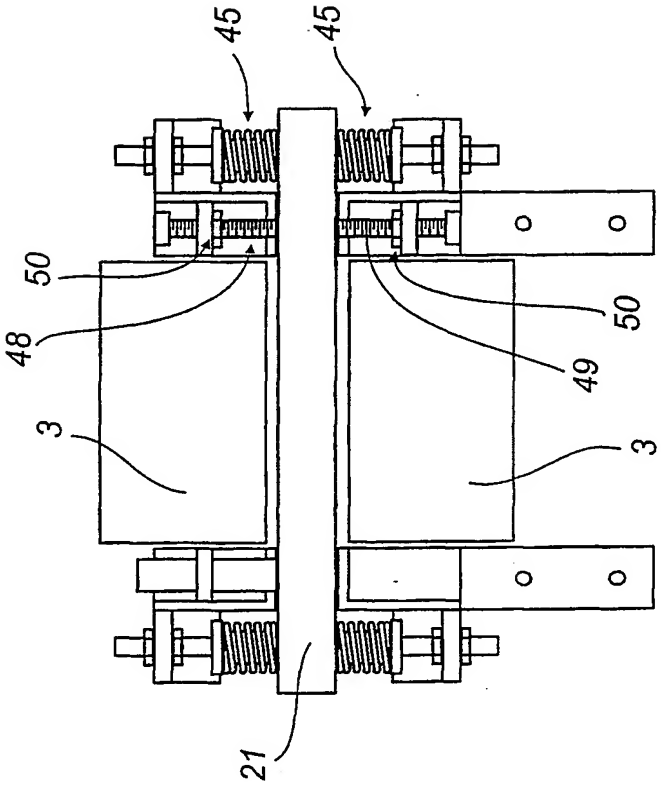


FIG. 13

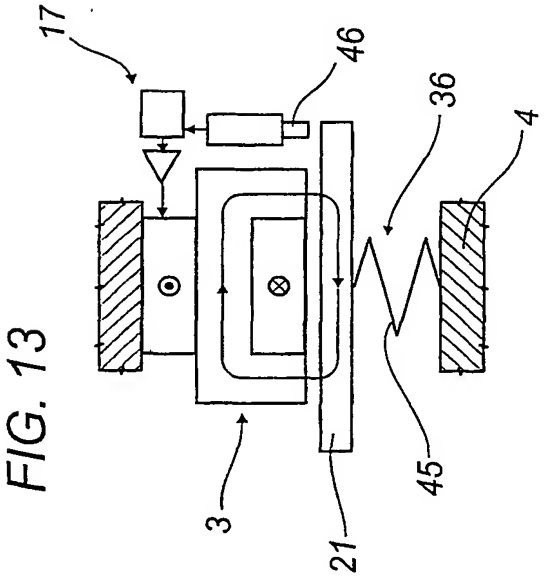
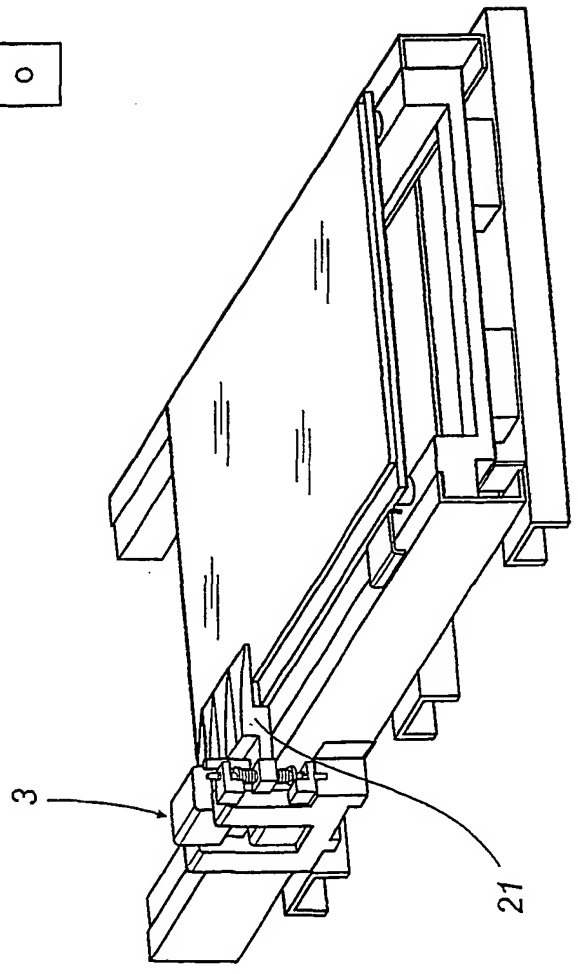


FIG. 15



INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/IB 02/00575

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A63B21/00 A63B22/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A63B B62M B68C H01F H02N F16C F16F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 473 963 A (AESCHBACH JAMES F) 12 December 1995 (1995-12-12) the whole document	1-11,16, 19,20, 22-25, 28-32,44
X	US 5 993 358 A (GUREGHIAN RICHARD S ET AL) 30 November 1999 (1999-11-30) column 2, line 12 -column 7, line 39 column 13, line 30 -column 13, line 37	1,6-8, 25-27, 35,36, 38-40, 44,45
A	figures	17

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 June 2002	04/07/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Squeri, M

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 02/00575

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 4 486 729 A (LEE HAE-CHUNG) 4 December 1984 (1984-12-04) the whole document	1-5, 23-26, 28-30, 32,33, 44,45
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INTERNATIONAL SEARCH REPORT

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In onal Application No
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